WP6 status

Paolo Fessia

Summary

- Status of the WP6 and change of WP coordinator
- Lowβ quadrupole status
- Corrector status
- Cryostat status

Status and change of WP6 leader I

- Milestones
  - 6.1 “ Component qualification” fulfilled
  - 6.2 “ Basic magnet design” in preparation (delay 1 month)
- Deliverable
  - 6.1 “Basic Triplet Design” Main report written and published

Status and change of WP6 leader II

- Stephan Russenschuck is taking over the responsibility in order to guarantee adequate follow up despite 3-4 consolidation activities
- Due to the 3-4 incident 6 months delay have been matured up to now. It is very probable that with the partners we need to revise the plan for this work package according to the possible re-scheduling of project

Lowβ quadrupole

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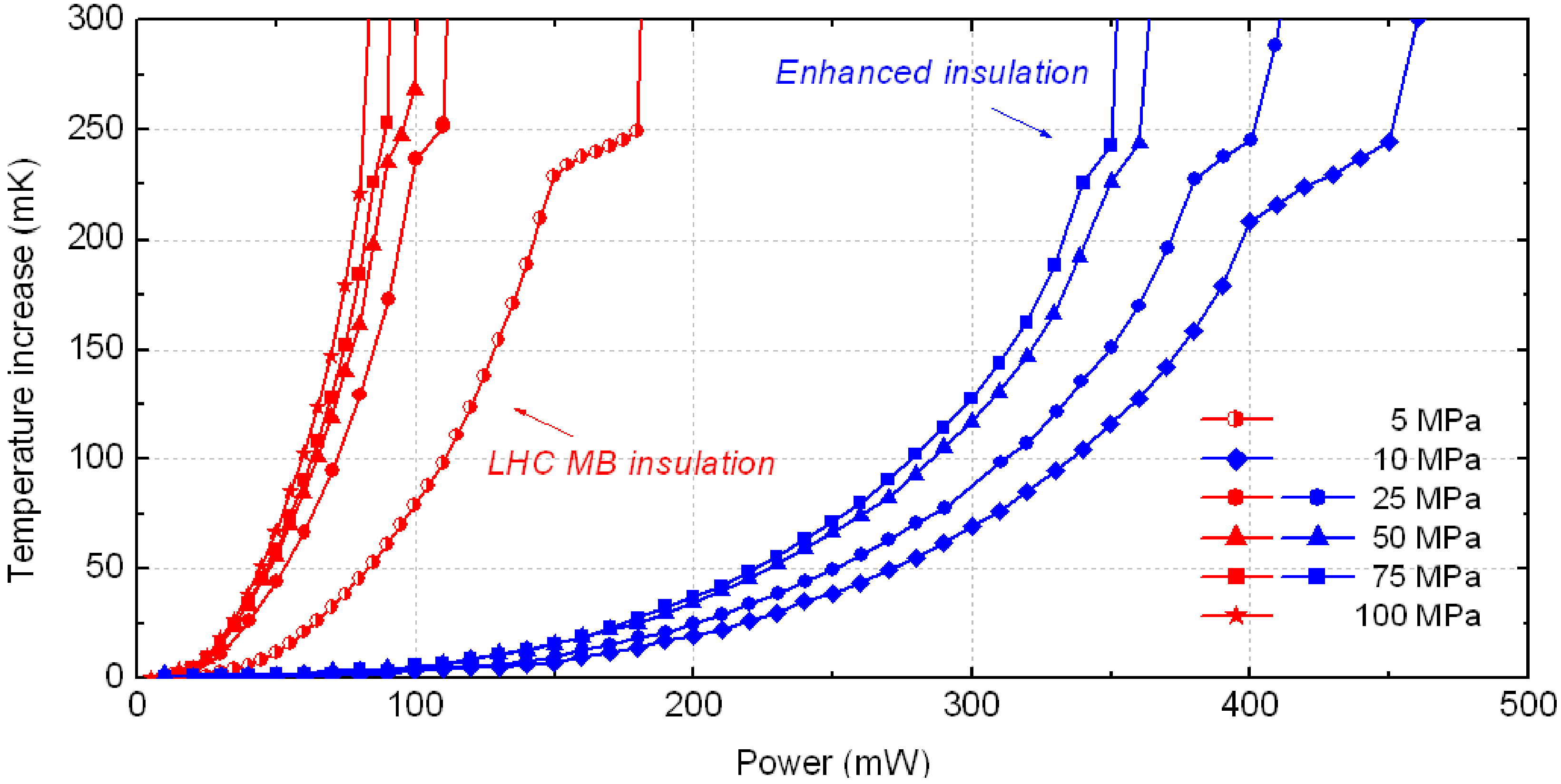
Enhanced insulation



Courtesy D. Richter P. Paolo Granieri

MQXC cross sections and iron yoke with heat exchanger(s)

Two possible solutions for heat exchanger proposed by the cryogenic team:

1) 2 heat exchanger in parallel inner diameter 71 mm (1st eval. wall thickness 2.5 mm). Hole diameter 80 mm
2) 1 heat exchanger inner diameter 100 mm (1st eval. wall thickness 3.5 mm). Hole diameter 110 mm

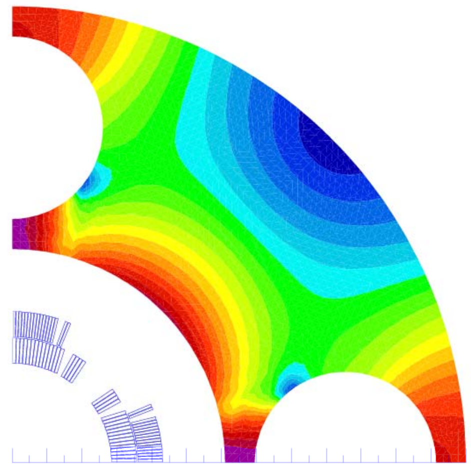
Both are large holes in the iron that affect transfer function and field quality

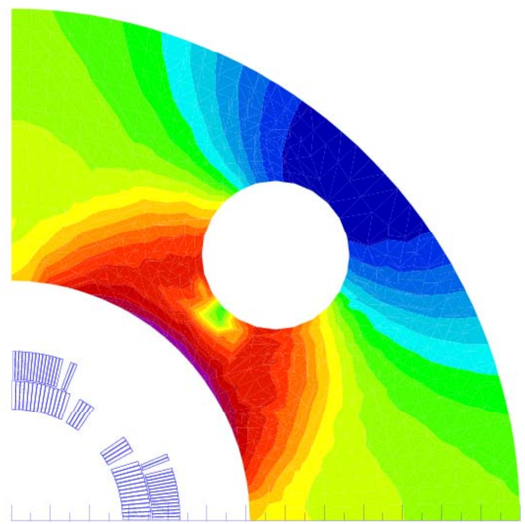
We can consider 2 possible configurations

1) Holes along the 2 mid-planes (larger effect on the transfer function)
2) Holes at 45 º

We prefer solution with 1 heat exchanger on the vertical mid plane because of

1) Simpler interconnect
2) Standardization of cold masses respect 1 heat exchanger at 45 º



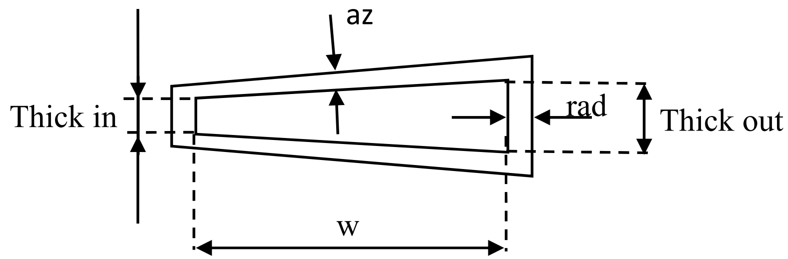


Courtesy F. Borgnolutti

Cables and Insulations Dimensions

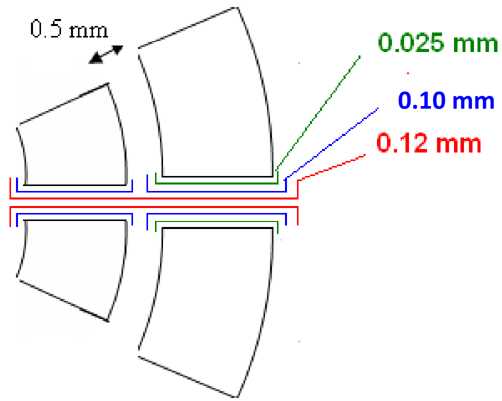
- Cables dimensions

	w (mm)	thick in (mm)	thick out (mm)	rad (mm)	az (mm)
cable 01	15.100	1.736	2.064	0.160	0.135
cable 02	15.100	1.362	1.598	0.160	0.145



- Critical current
  - Cable 01 (inner layer): 14800 A @ 10T (4680 A/T)
  - Cable 02 (outer layer): 14650 A @ 9T (4050 A/T)

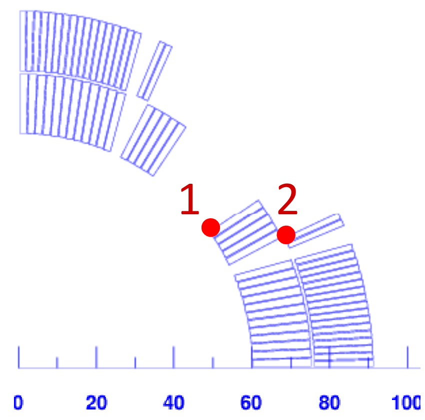
- Mid-plane and inter-layer thickness
  - Inter-layer thickness of 0.5mm
  - Mid-plane thickness
    - Layer 1 : 0.220 mm
    - Layer 2 : 0.245 mm



Coil Cross-Section

- Coil blocks features

Block Nº	Nb Cond	r (mm)	φ (º)	γ (º)	cable type
1	12	60.00	0.2101	0.000	Cable 01
2	5	60.00	25.728	27.757	Cable 01
3	17	75.92	0.1849	0.000	Cable 02
4	2	75.92	23.501	22.762	Cable 02



MQXC V24

- Angular position of the point 1 & 2

  (mechanical requirement: angles < 41º)

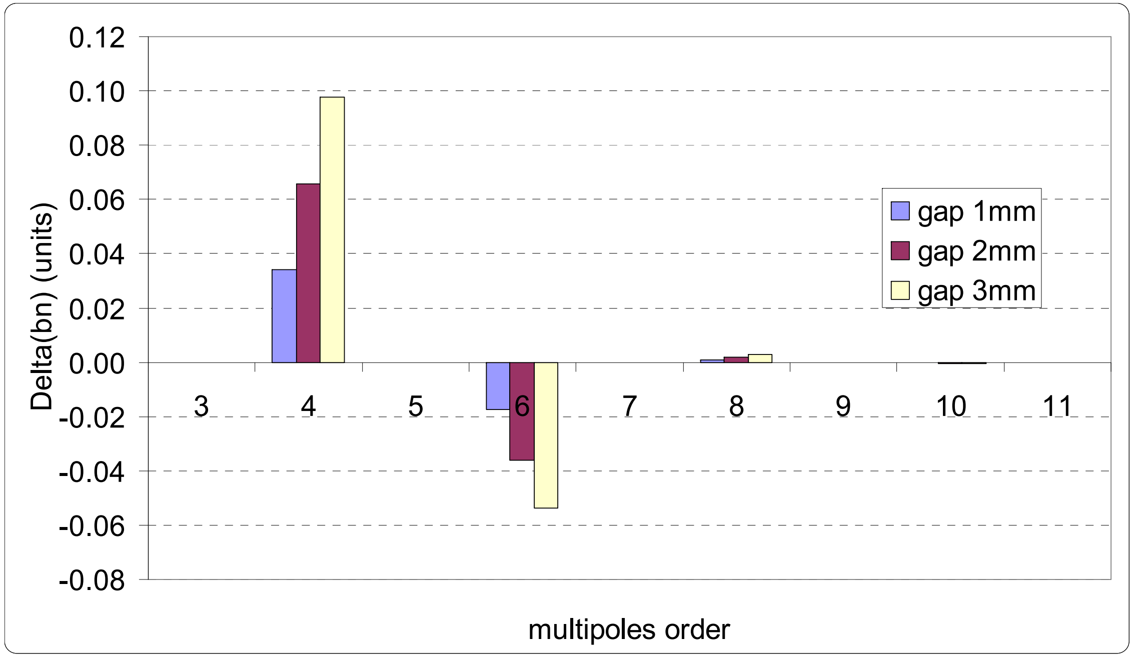
  – Point 1: ~35º

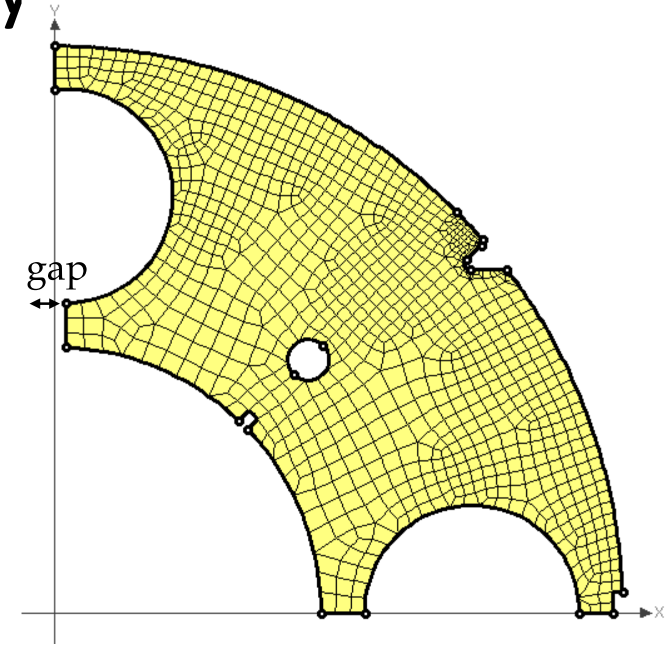
  – Point 2: ~26º

Courtesy F. Borgnolutti

Effect of a slot in the iron on the magnetic field quality

- Odd multipoles are not affected
- Only even multipoles b_4, b_6, b_8 and b_{10} are affected (multipole variation higher than 0.0001 unit)

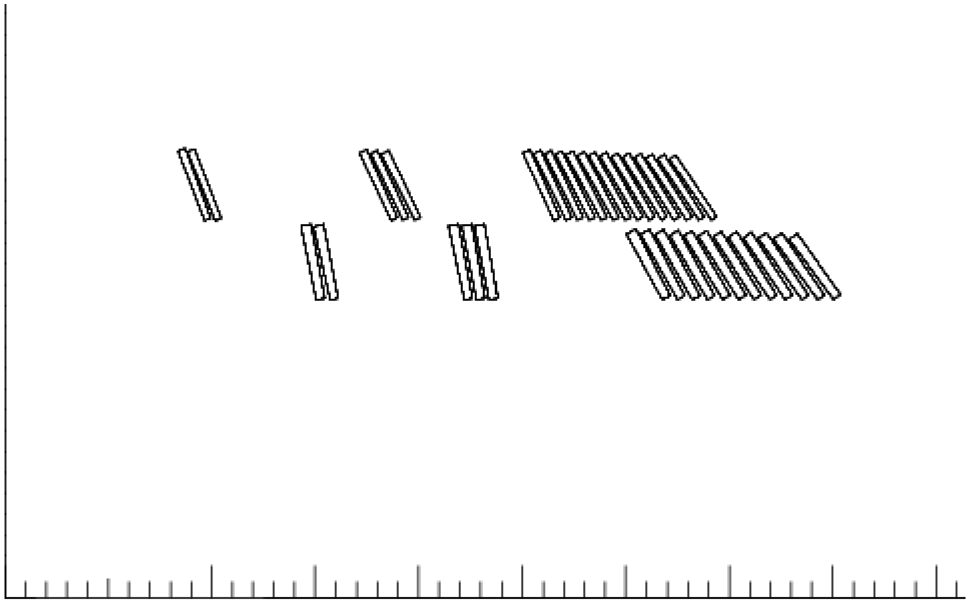


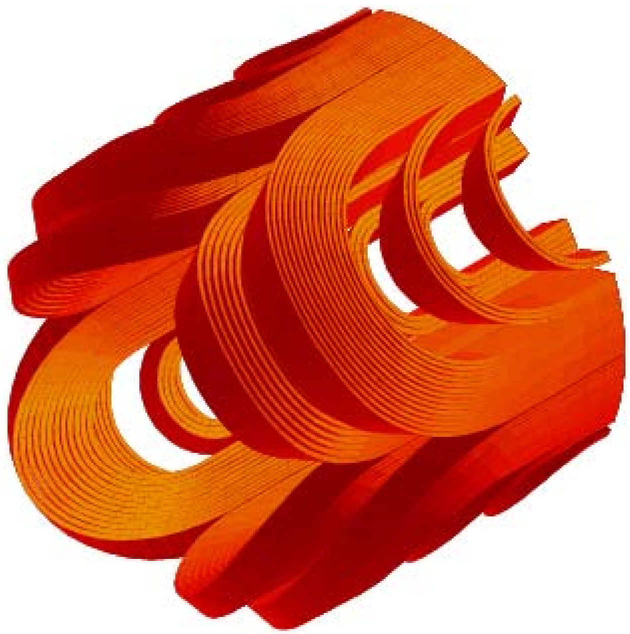


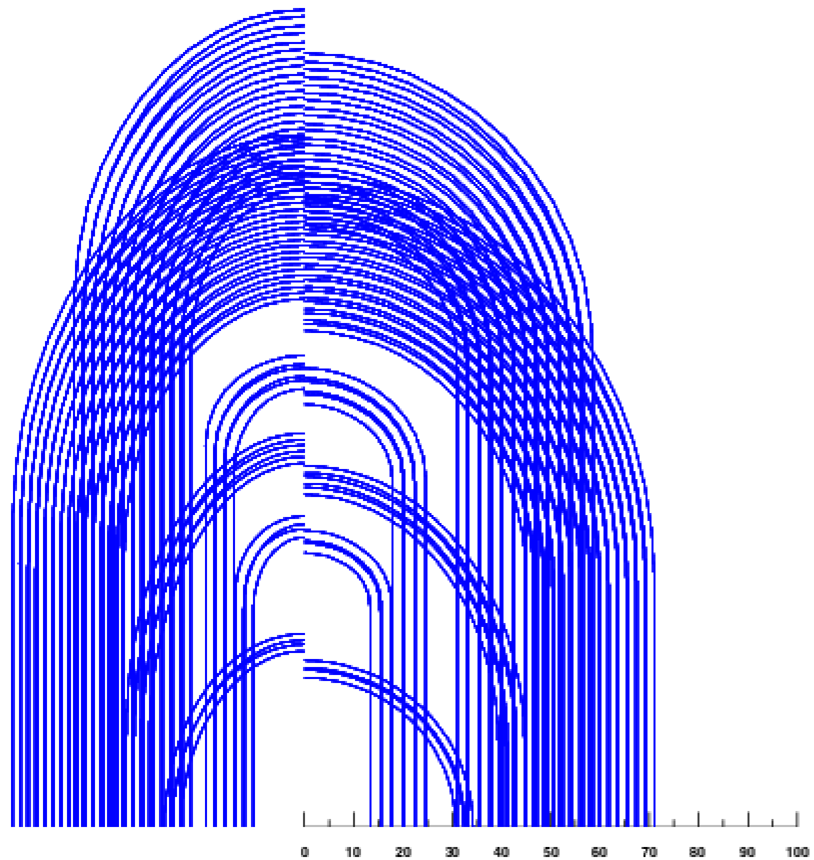
	gap 1mm	gap 2mm	gap 3mm
Δ b4	0.0340	0.0656	0.0978
Δ b6	-0.0174	-0.0362	-0.0536
Δ b8	0.0010	0.0020	0.0029
Δ b10	-0.0002	-0.0004	-0.0006

Courtesy F. Borgnolutti

NCS head design

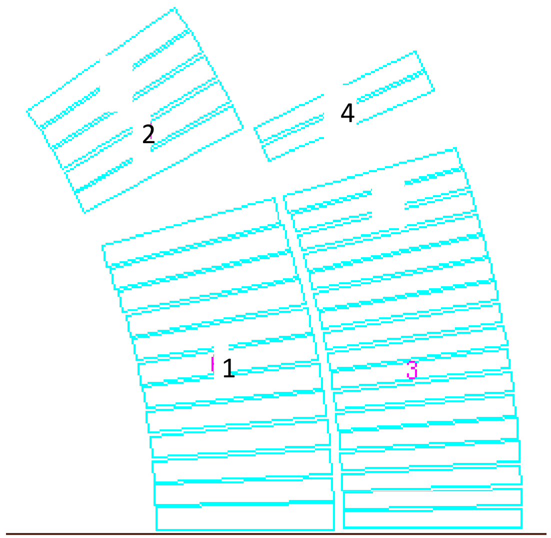






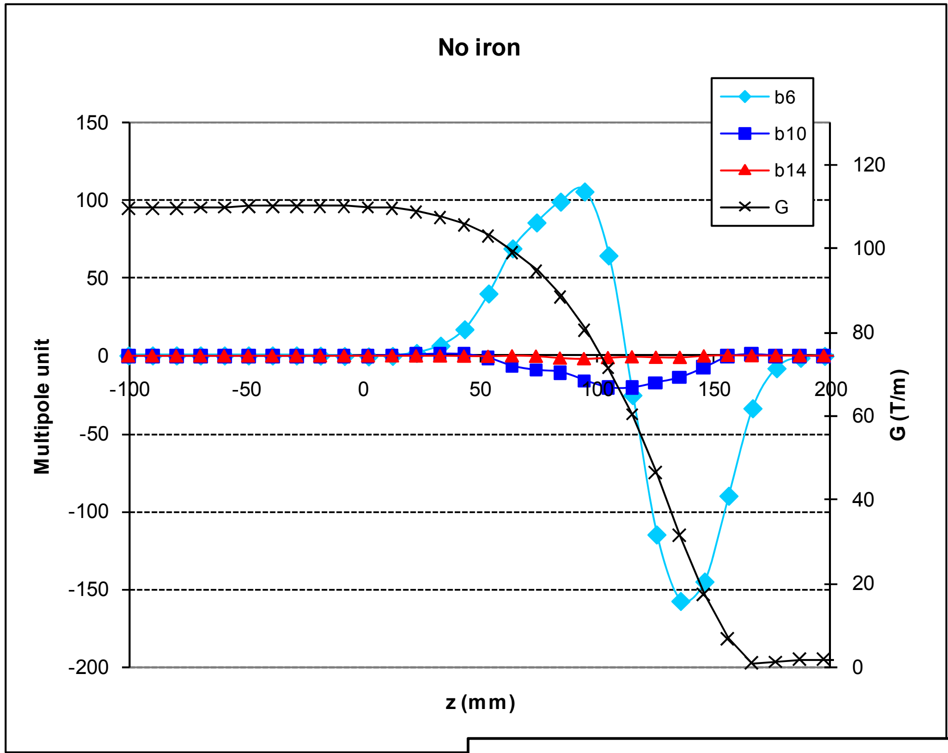
Peak field in the head, 30 mm of coil more and a lot more of margin in the head

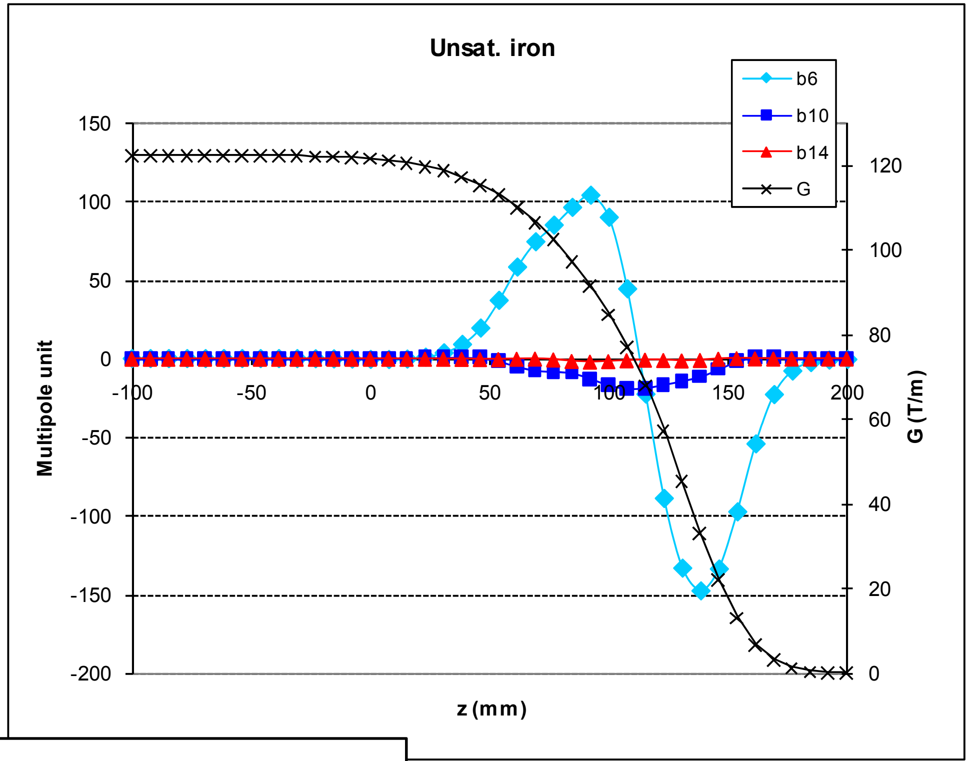
		straight part		head	B peak		ss field	% ss cur
no Iron Yoke	cable 01	BS1	6.5	6.6	cb01			
		BS2	7.3	7.4		**7.4**	9.6	77
	cable 02	BS3	5.7	6.1	cb02			
		BS4	6.1	6.4		**6.4**	8.4	75
unsat Yoke	cable 01	BS1	7.3	7.3	cb01			
		BS2	8.1	8.1		**8.1**	9.9	82
	cable 02	BS3	6.4	6.7	cb02			
		BS4	6.8	7.2		**7.2**	8.8	82
real Yoke	cable 01	BS1	7.1	7.2	cb01			
		BS2	7.9	8.0		8.00	9.8	81
	cable 02	BS3	6.6	6.6	cb02			
		BS4	6.6	7.0		7.03	8.7	81

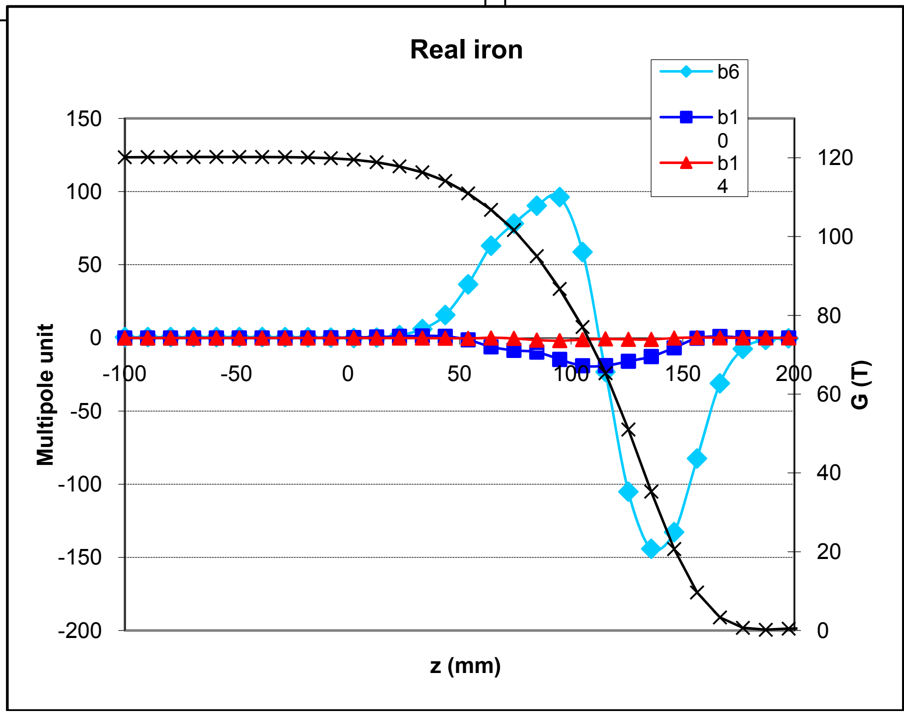


	no yoke	unsat yoke	real iron
Lmag	104	117	116
b6	-2.9	-2.8	-2.8
b10	-4.0	-3.8	-3.6
b14	-0.3	-0.4	-0.3

Uncertainty: systematic coil length error 3 mm-> shift between heads->+/-0.9 Δb6
Random: variation coil length 1σ 2mm-> shift between heads->+/-0.6 Δb6
This gives an uncertainty of +/- 0.03 for a straight part of 7000 mm and a random of 0.02.
We will neglect it

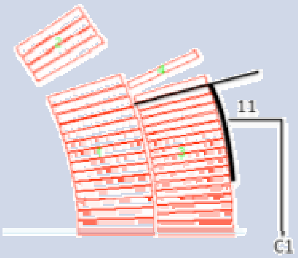
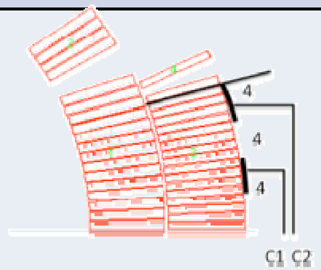
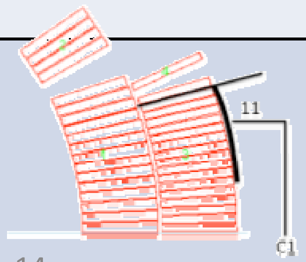






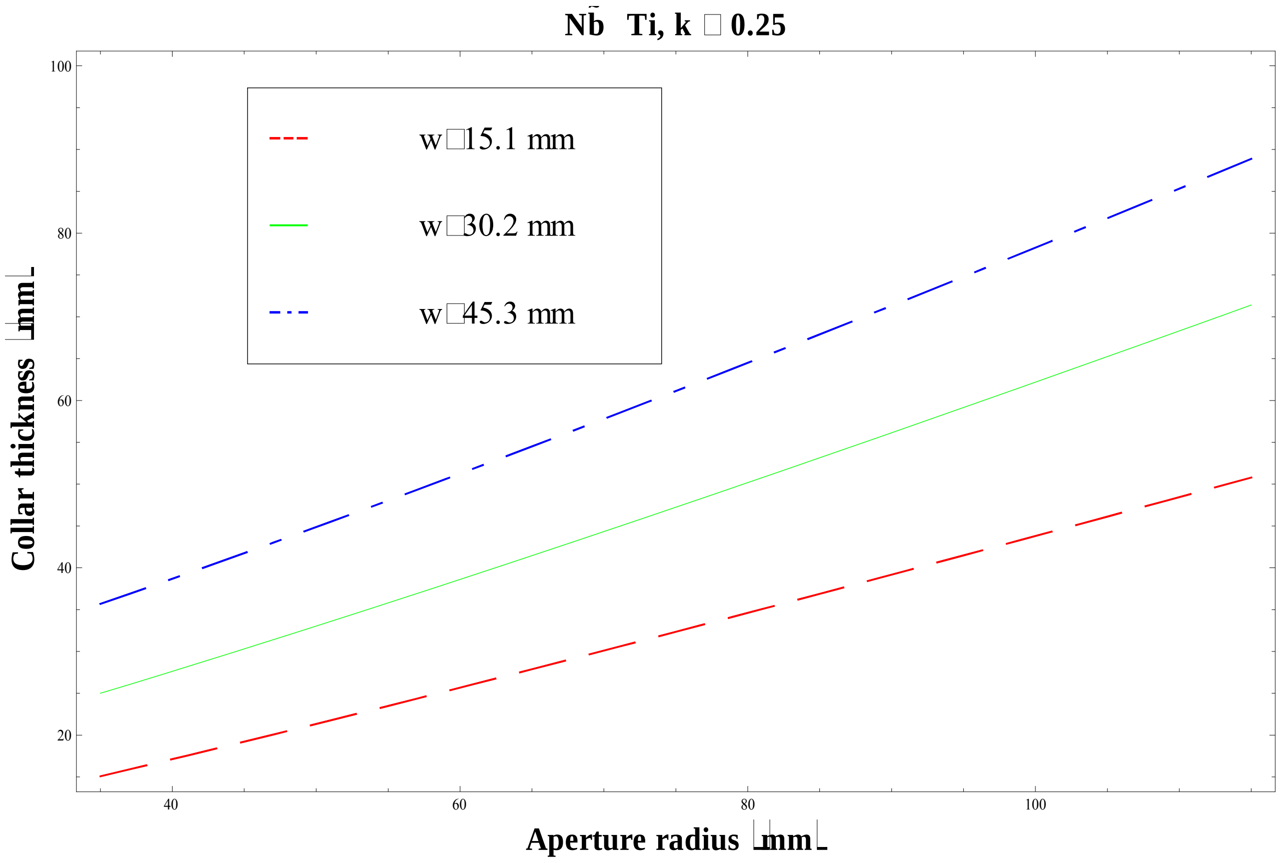
Courtesy F. Borgnolutti

Protection Study

		Nominal Current		Half Current		
Setup		**T peak**	**MIITs**	**T peak**	**MIITs**	
Dump resistor 40 mOhm, 10 ms delay		117	33.6	--	--	
		157	33.3	78	23.0	
	20ms extra delay	157	36.4	78	23.7	Hot spot in outer layer
	only half of the heaters	220	38.1	103	27.5	
		180	35.2	86	24.5	
	20ms extra delay	217	38.0	104	27.6	
	only half of the heaters	221	43.4	102	30.8	
	+ Dump Resistor	118	29.4	50	15.2	Hot spot close to heater
	+ Dump Resistor, half of heaters	136	29.8	--	--	Heater failure uncritical

Courtesy N. Schwerg

Collar thickness scaling based on MQXB

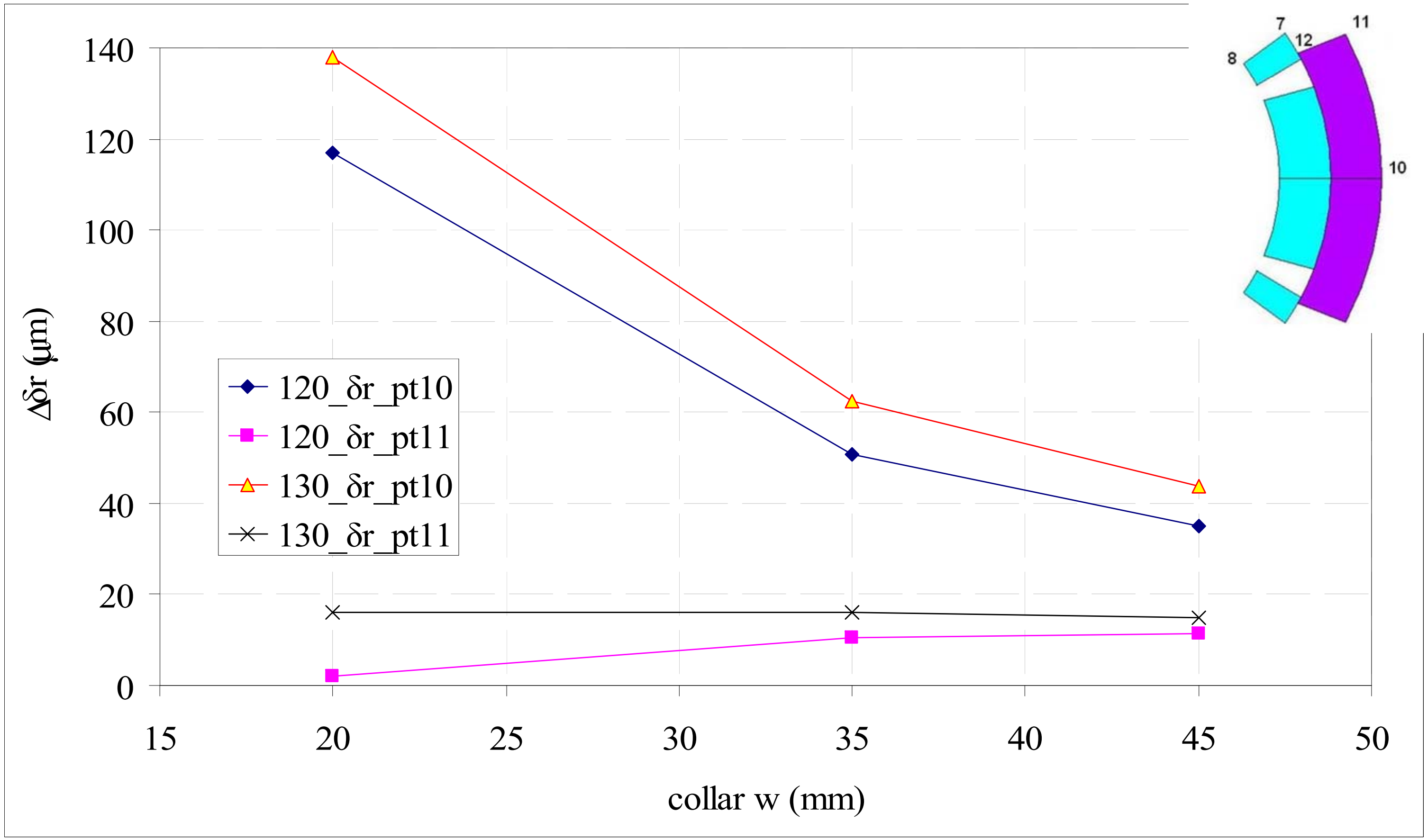


- Scaling based on radial collar displacement
- The collar width is obtained by solving:

$$sp \propto \left(\frac{0.5 \times w_{col} + r_i + w_{coil}}{w_{col}}\right)^3$$

Aperture radius [mm]	Collar thickness [mm]
55	35
60	39
65	42

FE analysis – radial displacement



Courtesy F. Regis

Studying options

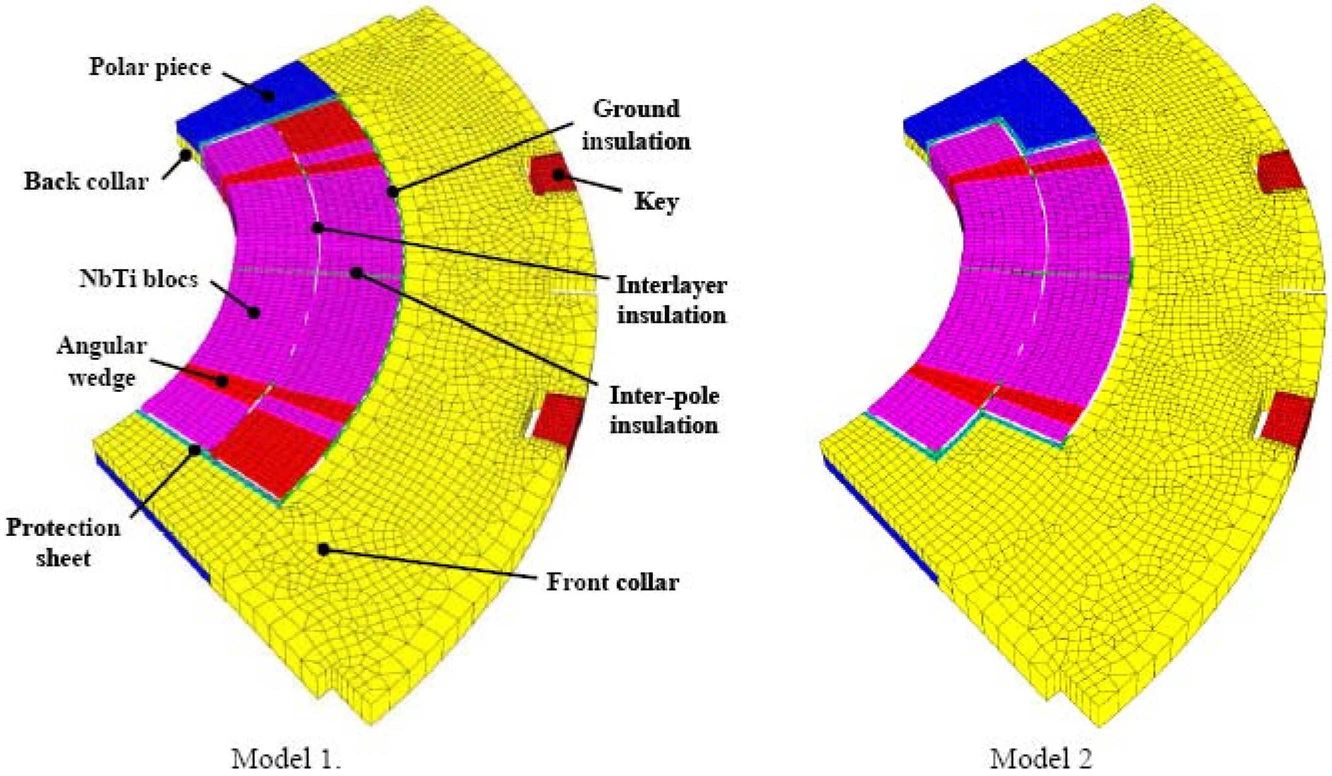
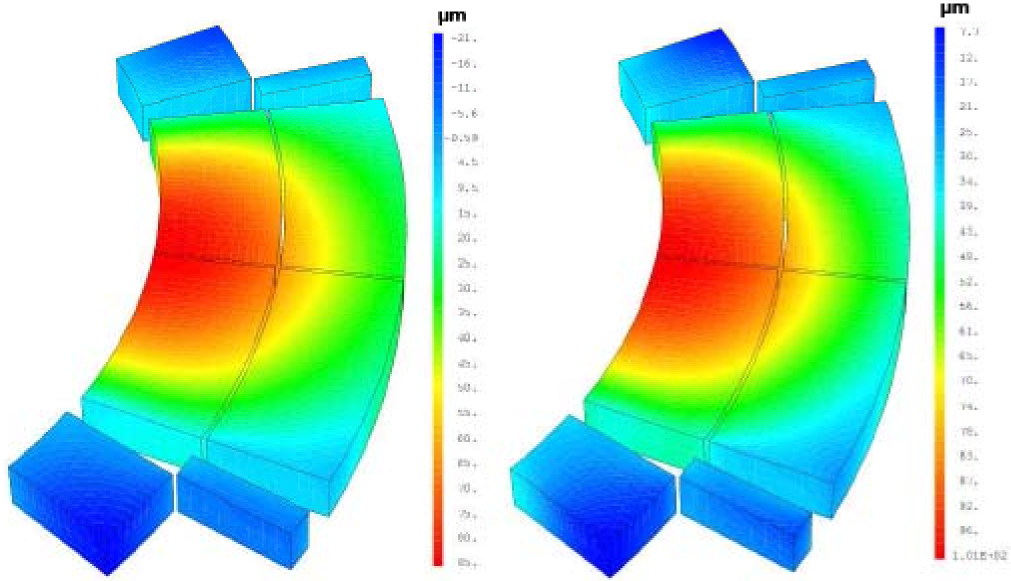


Fig.2: Mechanical models.

Courtesy M. Segretti

Confirming 1st analysis and going beyond



With model 1　　*With model 2*

Fig.6: Radial displacement of conductor blocs due to Lorentz forces.

Courtesy M. Segretti

Correctors

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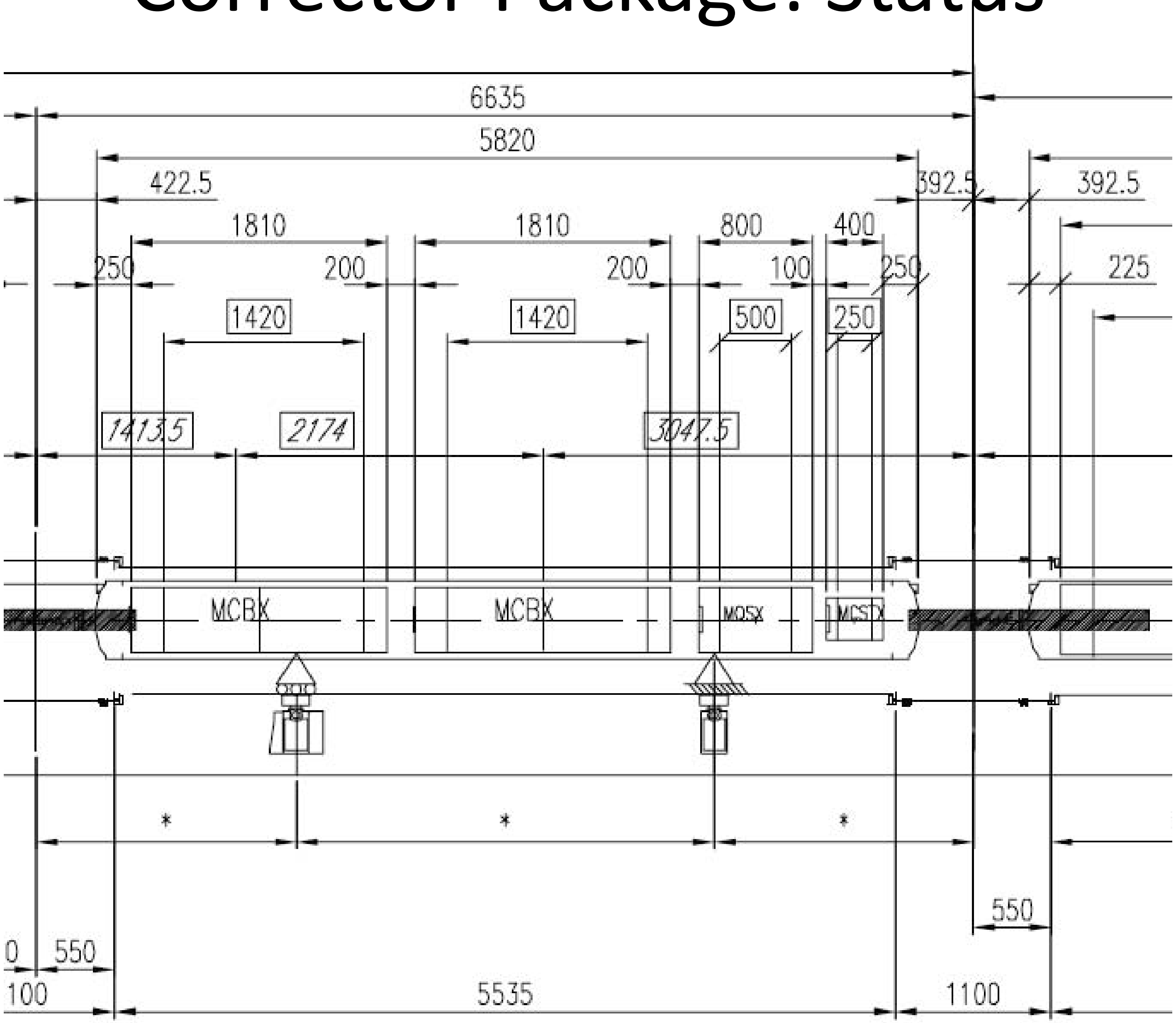
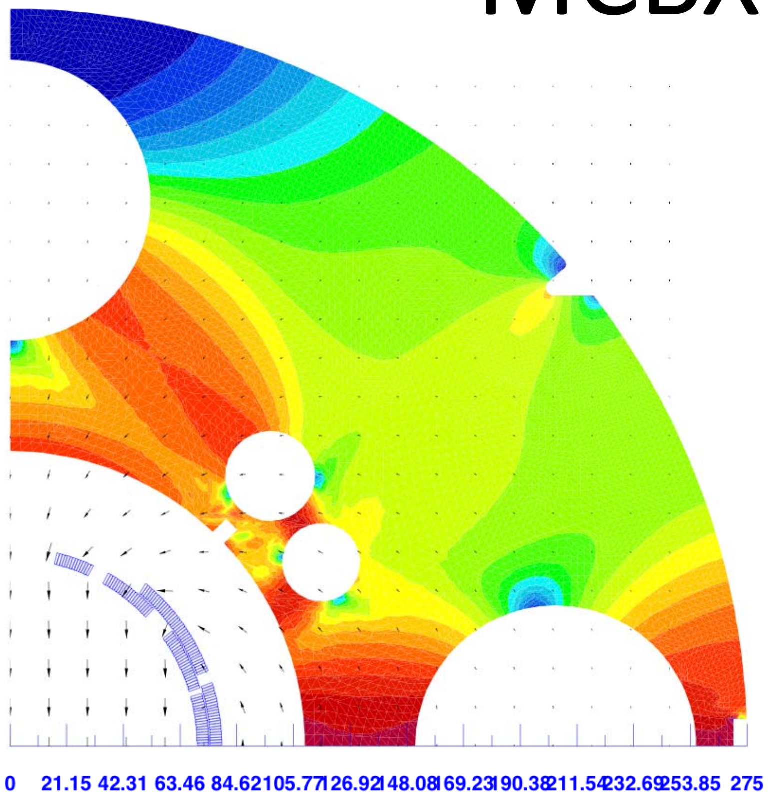
Corrector Package: Status



Courtesy M. Karppinen

MCBX Parameters



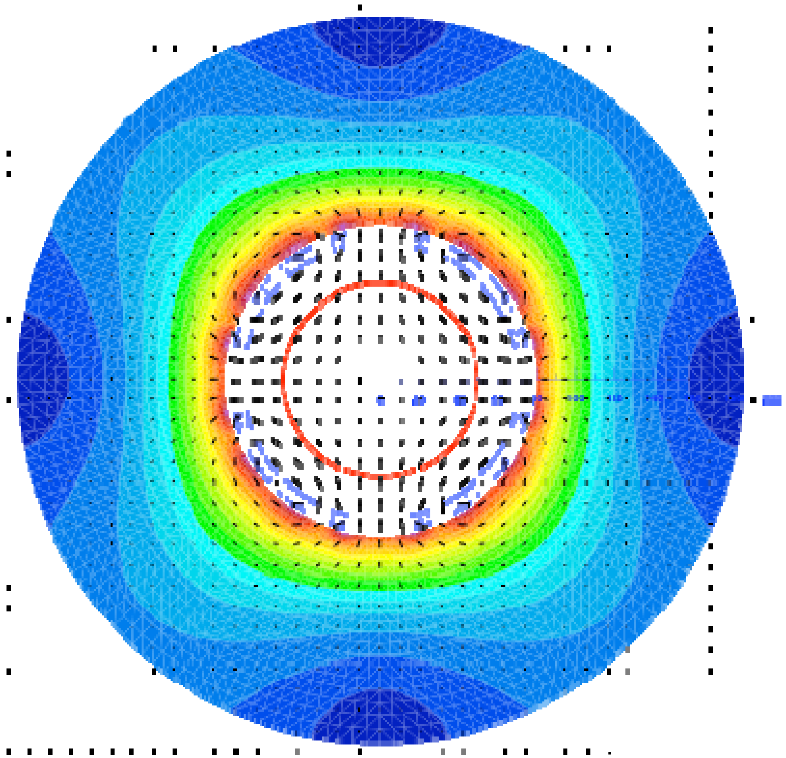
Cable:

- •18 X ø0.48 mm strand
- •ø6 μm filaments
- •Cu/Sc = 1.75
- •Polyimide insulation (80 μm)
- •Strand stock for 13-14 off magnets

	Unit	
Integrated field	Tm	**6**
Nominal field	T	**4.2**
Mag. length	m	**1.42**
Nominal current	A	**2500**
Stored energy	kJ	**240**
Self inductance	mH	**77**
Working point		**<75%**
Cable width/mid-height	mm	**4.37 / 0.845**
Total length	m	**1.8**
Aperture	mm	**Ø140**
Total mass	kg	**~2700**

Courtesy M. Karppinen

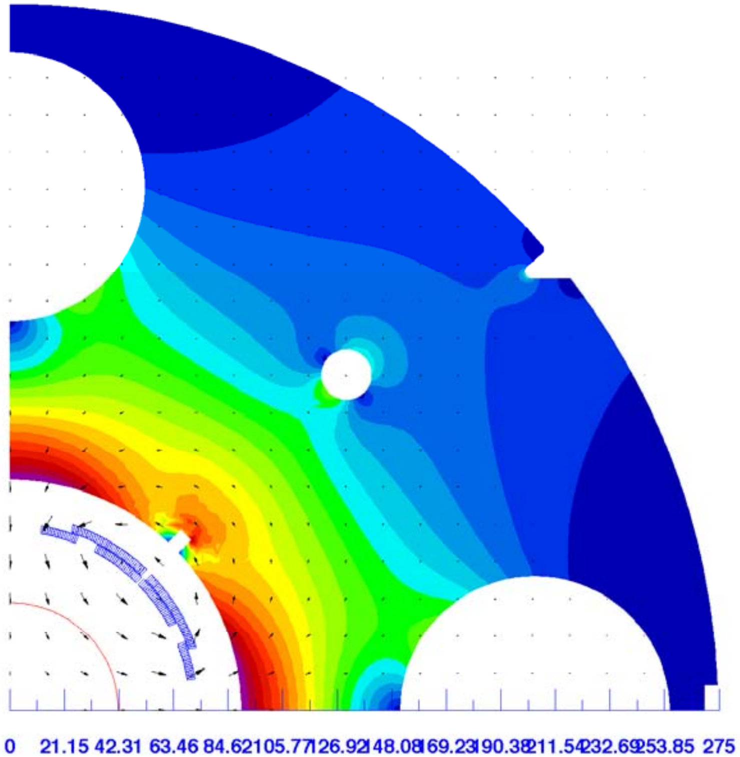
MQSX: Low current version

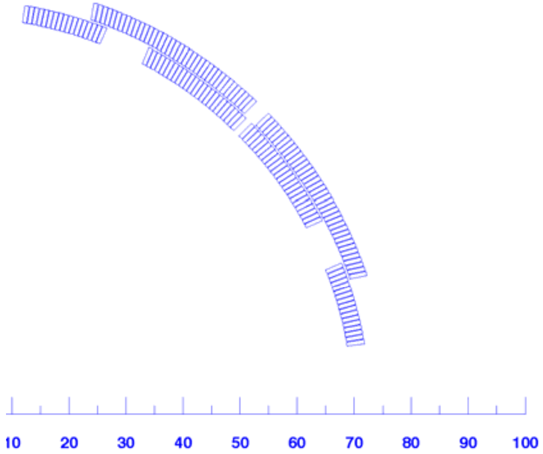


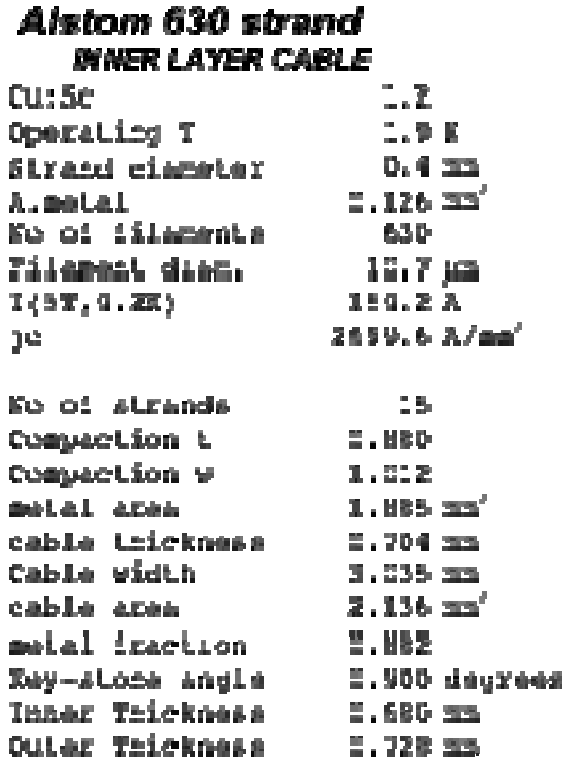
Field errors @ 40 mm	10 % of I_{nom}	I_{nom}
a_6(units)	0.007	**-11.9**
a_{10}(units)	-0.002	-0.210
a_{14}(units)	-0.076	-0.050

Courtesy M. Karppinen

MQSX: High current version





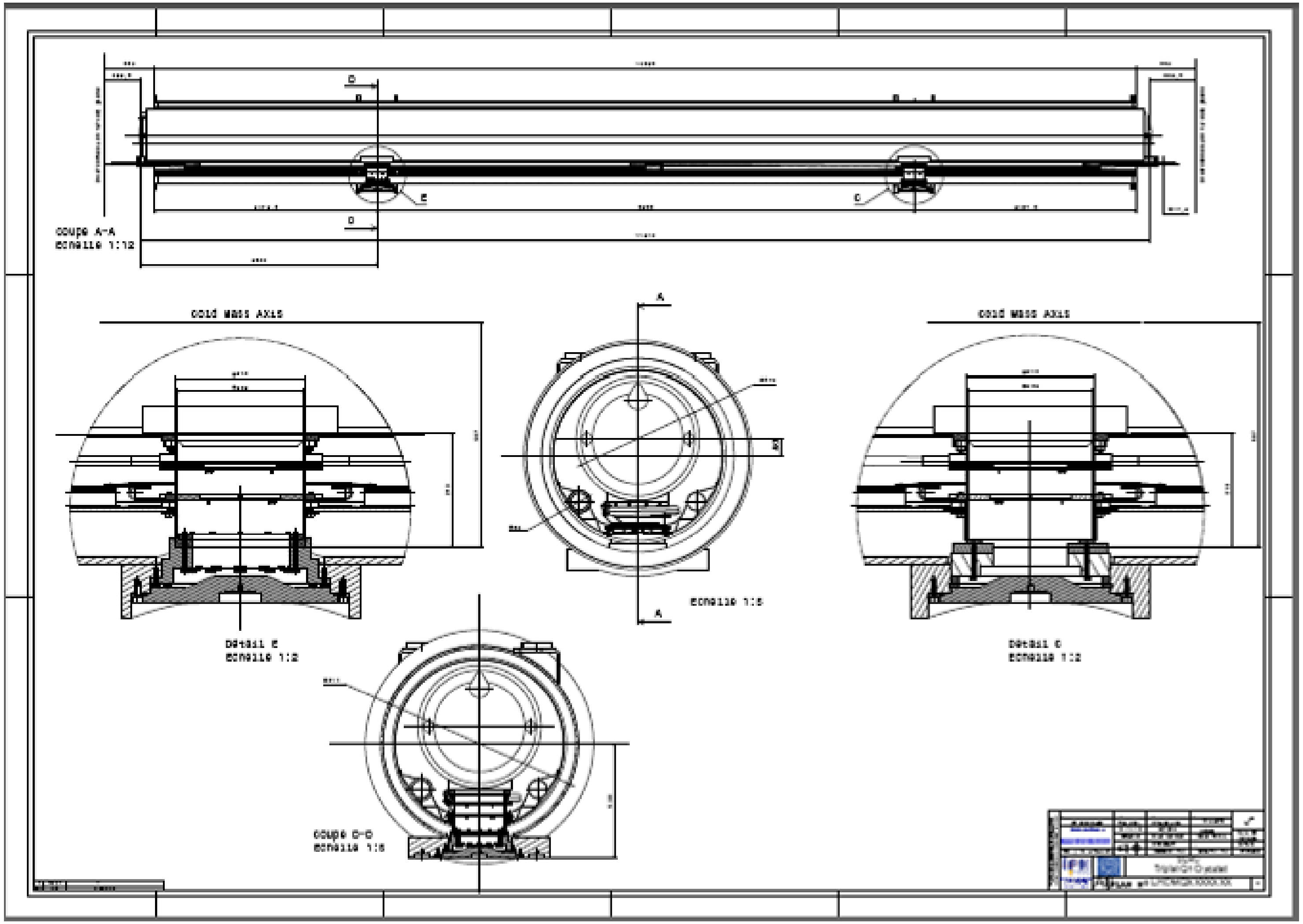


Field errors @ 40 mm	10 % of I_{nom}	I_{nom}
a_6(units)	0.050	-0.639
a_{10}(units)	0.004	-0.003
a_{14}(units)	-0.109	-0.109

Courtesy M. Karppinen

Cryostat

CNRS CERN support



INNER TRIPLET QUADRUPOLE CRYOSTAT
First draft drawing from CNRS